



OIL LIFE EXTENSION

Best Environmental Practices for Fleet Maintenance • November 2001



Why test your engine oil?

Fleet maintenance facilities generate a tremendous amount of used oil from routine engine maintenance. Engine oil changes are typically performed according to mileage or calendar schedules that are based on average data for a wide variety of vehicles. As a result, engine oil changes are often performed more frequently than necessary. If this is the case at your facility, you are purchasing and throwing away more oil than you need to. This fact sheet describes how a testing program can extend engine oil life and thus lower oil consumption, reduce used oil generation, and decrease operating costs with no risk to your vehicles.

Advantages of oil testing

Resource Conservation. Oil is a nonrenewable resource; oil supplies are decreasing, which will drive prices higher. By extending engine oil life through testing, you can help save this nonrenewable resource!

Source Reduction. Reducing oil change frequency through testing reduces used oil generation at the source.

Cost Savings. Extending oil life reduces oil purchase and disposal costs as well as labor spent on changing oil.

Monitoring Maintenance Practices. After a few tests, you can identify trends to verify that routine maintenance is performed adequately.

Keeping Minor Repairs Minor. Testing provides early warning of engine component problems before they become serious, which will: 1) reduce repair costs, 2) help you anticipate vehicle down time, and 3) minimize “hit and miss” disassembly and inspection.



ENVIRONMENTAL ISSUES WITH USED OIL

- 1 2.7 billion gallons of oil is sold annually in the U.S.
- 2 50% of oil is consumed and 50% becomes used oil; 31% of the used oil, or about 420 million gallons, is never recycled! Much of it goes into the environment.
- 3 Used oil is recycled by being burned for energy or re-refined. Burning oil results in air pollution that includes sulfur and hydrocarbon emissions.
- 4 3 to 5% of the used oil that is re-refined ends up as hazardous waste sludge.

Create an oil life extension program at your facility

There are four aspects of a successful, cost-saving oil life extension program: 1) establishing baseline information, 2) conducting engine oil sampling, 3) testing oil, and 4) evaluating test results.

1) Establishing baseline information

Documenting the following baseline data for each of your vehicles provides information that will help you evaluate test results and make decisions about extending oil life:

- Oil change intervals
- Operating environment
- Recent maintenance or repair work
- Brand and type of oil used
- Vehicle age



2) Conducting engine oil sampling

Engine oil sampling should be performed at regular intervals. Begin your program by sending samples to an off-site laboratory for testing.

Consider this: Collecting engine oil samples does not require much extra labor, particularly if samples are collected during scheduled preventive maintenance and safety checks. Sampling labor is usually offset by reductions in oil change labor.

Sampling tips:

- Run the engine, and then sample soon after turning off the engine.
- Collect a sample by 1) installing a valve to draw off oil just before the filter, 2) withdrawing oil through a narrow hose inserted in the dipstick tube, or 3) taking a sample when the oil is changed (within 15 minutes of engine shutoff).
- Keep hands out of sample bottles and keep bottles tightly capped before and after sampling to minimize foreign contamination.
- Consult oil testing companies for sampling equipment and methods.

METAL CONTAMINATION AND ITS SOURCES

| | |
|-----------------|---|
| Aluminum | <ul style="list-style-type: none"> • Piston or bearing wear • Hydraulic system pumps • Transmission components |
| Chromium | <ul style="list-style-type: none"> • Piston rings • Roller bearings in geared compartments • Valve stem wear |
| Copper | <ul style="list-style-type: none"> • Thrust bearing wear • Oil cooler core “leaching” • Transmission or steering disc wear |
| Iron | <ul style="list-style-type: none"> • Gear, shaft, or liner wear |
| Lead | <ul style="list-style-type: none"> • Bearing wear |

3) Testing oil

The following are sources of engine oil contaminants.

- **Antifreeze** contaminates engine oil through a coolant leak, causing bearing damage and piston, ring, and liner wear. The first sign of a coolant leak is detection of sodium, potassium, or boron in the oil.
- **Metals** from engine wear contaminate engine oil (see table below, “Metal Contamination and its Sources”).
- **Fuel** contaminates engine oil as a result of faulty injectors and can reduce oil lubricating qualities, lower oil viscosity, and lead to bearing failure. As little as 1% fuel content decreases oil viscosity by 4 to 6 percent.
- **Sand and dirt (silicas)** enter engine oil from outside sources and cause abrasive wear of engine parts.
- **Water** contamination of engine oil is usually caused by condensation in the crankcase. Large amounts of water contribute to formation of metal-corroding acids that can damage pistons, rings, and the liner. Oil performance is affected when its water content exceeds 0.3 percent.

Selecting test methods: Most fleet maintenance facilities test engine oil for a variety of contaminants and therefore use more than one testing method. Common tests for oil life extension include testing for water, metals, viscosity, antifreeze, and dielectric constant (see table on next page, “Engine Oil Testing Methods at a Glance”).

On-site testing: After you see how you can extend oil life based on the test results, consider purchasing on-site oil analysis equipment to lower your program costs and significantly reduce your waiting time for results.

On-site testing reduces the lag time between sampling and decision-making because test results are obtained almost immediately. On-site testing equipment ranges from small, hand held units



Hand-held oil analyzers give test results quickly.

which simply measure dielectric constant, to more complex analyzers that can identify specific contaminants and produce oil quality reports. Hickam Air Force Base in Hawaii used both a LubriSensor and a Computational Systems Inc. (CSI) Model 5100 oil analyzer to conduct their oil analysis program. They found that both provided comparable results to off-site laboratory analysis. The Lubri-Sensor costs about \$600 and the CSI 5100 costs about \$8,000.

ENGINE OIL TESTING METHODS AT A GLANCE

The following test methods are commonly used to evaluate contaminant levels in oil. Costs vary depending on the level of detail required.

| Method | Description | Approximate Cost |
|--|--|--|
| Lab Oil Analysis includes: • Physical Tests * Viscosity * Antifreeze Contamination * Fuel Soot Percentage * Water Contamination * Fuel Dilution • Contaminant Metals • Visible Solids/Metals • Wear Metals Analysis • Contaminant Metals • Optional Tests (TAN)(TBN) | Lab tests include wear analysis on bushings, piston valve, and ring/liner in PPM. Tests also list PPM of any coolant, dirt, or sludge in oil. Oil quality is also included as percent of fuel, grade, TBN, and viscosity. Plus a summary of results. | \$6.00 to \$24.00 depending on the number of tests and the type of tests--check with your local lab. |
| Dielectric Constant Test (CSI 5100) | Measures dielectric constant, which indicates the presence of fuel, water, or metal contaminants. | (TAN or TBN Screening tests may cost up to \$3.00 extra) \$8,800.00 (One time cost) |
| Oil Analyser (tribometrics, Inc.) | Measures viscosity, particle contamination, and wear particle concentration. | \$18,500.00 (one time cost). |

4) Evaluating test results

Most testing labs or equipment vendors will provide contaminant thresholds or action levels for specific test methods to help you decide when to change your oil. Having good baseline information is important when establishing fleet-specific action levels. The following rules of thumb apply to two common tests, the viscosity and dielectric constant tests:

- Action is needed if viscosity increases more than 20 percent, or decreases more than 10 percent, from the baseline.
- Changes in the dielectric constant indicate potential problems as follows:
 - A moderate increase indicates the presence of contaminants such as dirt, acids, soot, and oxidation products.
 - An extreme increase indicates the presence of water, antifreeze, or metal particles: immediate action is needed to prevent engine damage.
 - A moderate decrease indicates the presence of fuel: immediate action is needed to prevent engine damage.

Making the change!

Extending oil change intervals safely— a step-by-step approach

- 1) Select a few vehicles that can be easily monitored.
- 2) Gather vehicle history data such as oil consumption, current oil change interval, and vehicle driving condition information. Collect and test oil samples from two consecutive oil changes to establish baseline conditions.
- 3) If the vehicle baseline data indicates no oil quality problems, increase the oil change interval by 15 to 25 percent (for example, if the engine oil is currently changed after 4,000 miles, extend the change interval to 4,800 miles).
- 4) Test oil at the new change interval (for example, 4,800 miles) for two consecutive oil changes, and compare the results with the baseline oil test data.
- 5) If test results at the change interval are favorable, consider extending the change interval further. If the results are not favorable, reduce the change interval and repeat the testing.

VENDOR CONTACT INFORMATION

LubriSensor (for measuring dielectric constant on site)

Northern Technologies Int'l Corp.:
(800) 328-2433

CSI 5100 (for on-site oil analysis)

CSI: (865) 675-2110

For off-site oil analysis for various parameters

Herguth Laboratories, Inc.:
(800) 645-5227

For off-site oil sampling and Probilizer sampling ports

Titan Laboratories:
(800) 848-4826

Websites

National Oil Recyclers

Association:
www.noraoil.com

Oil Analysis.com:
www.noria.com/index.html

These vendors provided information for this fact sheet. This list is not complete: other vendors may provide similar or identical products and services.



Case studies:

Benefits of oil testing

Several fleet maintenance facilities (Eielson Air Force Base (AFB) in Alaska; Fort Lupton School District Maintenance Shop in Colorado; Hickam AFB in Hawaii; and the Idaho Engineering and Environmental Laboratory (IEEL), a Department of Energy facility) provided information about their oil testing programs for this fact sheet. As the following table indicates, each of these facilities realized environmental and cost benefits from extending engine oil life through oil testing.

| | EIELSON AFB | FORT LUPTON SCHOOL DISTRICT | HICKAM AFB | IEEL |
|------------------------------------|---|--|--|--|
| Number of vehicles | 800 vehicles (heavy machinery, trucks, and vans) | 23 buses | 659 vehicles (trucks, vans, cars, and various other) | 1,590 vehicles (buses, trucks, cars, and heavy machinery) |
| Oil testing | On site with CSI model 5100 Cost: \$8,000 | Off site by Titan Labs Cost: \$6/sample; “Probilizer” sampling port available for fleets | On site with CSI model 5100; Cost: \$8,000 | Off site with Herguth Labs Cost: variable |
| Number of samples per month | 40 to 60 | 50 | 45 | 32 |
| Time to sample per analysis | 1 hour to sample and analyze | 5 minutes to collect one sample | 30 minutes to sample and analyze | 5 to 10 minutes to collect one sample |
| Parameters analysis | Silicas Iron Metals Water | Silicas Metals Water Viscosity Percent fuel Percent antifreeze | Silicas Ferrous materials Metals Water | Non-metallic contaminants Heavy metals Water Viscosity Percent fuel Percent antifreeze |
| Oil change interval | Average oil change interval tripled | Before: 4,000 miles After: 8,000 miles | Average oil change interval doubled | Interval increased by about 1,000 miles, and labor decreased |
| Used oil disposal per year | Before: 26,260 gallons After: 3,400 gallons Savings: \$435 | Reduced by 80 gallons Savings: \$230 | Before: 2,385 gallons After: 500 gallons | Before: 10,000 gallons After: 8,500 gallons Savings: \$600 |
| Engine oil purchased | Reduced by 13% Savings: \$26,000 | Decreased but not quantified | Before: 2,255 gallons After: 495 gallons | Decreased but not quantified |
| Engine wear and tear | No engines lost due to oil failure in 5 years of oil testing (this is also attributed to synthetic oil use) | Not tracked | Not tracked | Saves about 3 engines per year that cost \$6,000 to \$25,000 each. Saves the most on bus engines (\$25,000 for a new engine and \$12,000 to rebuild an old engine) Net savings: at least \$40,000 per year |
| Estimated payback period | 4 months | 7 months | About 18 months | About 1 year |

Your state or local government environmental agencies have additional information about compliance and pollution prevention opportunities for auto repair shops and fleet maintenance operations in your state or area. For information on California regulatory compliance issues contact your nearest

Department of Toxic Substances Control (DTSC) Regional Office by calling 1-800-728-6942. You may also access the CAL EPA website at www.calepa.ca.gov for links to California Regulatory Agencies. To obtain additional copies “The Pollution Prevention Tool Kit, Best Environmental Practices for Auto Repair” (Document number 626) or “The Pollution Prevention Tool Kit, Best Environmental Practices for Fleet Maintenance” (Document 625) contact “DTSC’s Office of Pollution Prevention and Technology Development (OPPTD)” at 1-800-700-5854. Accompanying videos, “Profit Through Prevention” are available at the same phone number for either auto repair (Document number 1504) or fleet maintenance (Document number 1504). DTSC’s OPPTD also provides technical assistance and pollution prevention resources to businesses and government agencies. Electronic versions of the fact sheets can be found at: www.dtsc.ca.gov/PollutionPrevention/Vehicle_Service_Repair.html



Mention of trade names, products, or services does not convey, and should not be interpreted as conveying, U.S. EPA, California Department of Toxic Substances Control (DTSC) or any local government approval, endorsement, or recommendation.

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